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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09 941,612	08 30 2001	Yoshinobu Aoyagi	1794-0141P	6758

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EXAMINER

SONG, MATTHEW J

ART UNIT	PAPER NUMBER
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1765

DATE MAILED: 11 08 2002

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Please find below and/or attached an Office communication concerning this application or proceeding.

**Office Action Summary**

Application No.

09/941,612

Applicant(s)

AOYAGI ET AL

Examiner

Matthew J Song

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☐ Responsive to communication(s) filed on \_\_\_\_.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 1-25 is/are pending in the application.
- 4a) Of the above claim(s) 22-25 is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-21 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 30 August 2001 is/are: a) ☐ accepted or b) ☒ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on \_\_\_\_ is: a) ☐ approved b) ☐ disapproved by the Examiner.  
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

**Priority under 35 U.S.C. §§ 119 and 120**

- 13) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).  
a) ☒ All b) ☐ Some \* c) ☐ None of:  
1. ☒ Certified copies of the priority documents have been received.  
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_.  
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).  
\* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).  
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

**Attachment(s)**

- 1) ☒ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s) \_\_\_\_
- 2) ☒ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) \_\_\_\_ 6) ☐ Other:

## DETAILED ACTION

### *Election/Restrictions*

1. Restriction to one of the following inventions is required under 35 U.S.C. 121:
  - I. Claims 1-21, drawn to a method, classified in class 117, subclass 2.
  - II. Claims 22-23, drawn to a product, classified in class 257, subclass 607.
  - III. Claims 24-25, drawn to an apparatus, classified in class 117, subclass 200.
2. Inventions I and II are related as process of making and product made. The inventions are distinct if either or both of the following can be shown: (1) that the process as claimed can be used to make other and materially different product or (2) that the product as claimed can be made by another and materially different process (MPEP § 806.05(f)). In the instant case the product as claimed can be made by another and materially different process, such as one where the impurities are not supplied in a pulsed manner, such as a continuous manner.

Inventions I and III are related as process and apparatus for its practice. The inventions are distinct if it can be shown that either: (1) the process as claimed can be practiced by another materially different apparatus or by hand, or (2) the apparatus as claimed can be used to practice another and materially different process. (MPEP § 806.05(e)). In this case the apparatus as claimed can be used to practice another and materially different process such as depositing a pure semiconductor without impurities.

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Inventions II and III are related as apparatus and product made. The inventions in this relationship are distinct if either or both of the following can be shown: (1) that the apparatus as claimed is not an obvious apparatus for making the product and the apparatus can be used for making a different product or (2) that the product as claimed can be made by another and materially different apparatus (MPEP § 806.05(g)). In this case the product as claimed can be made by another and materially different apparatus, such as an apparatus that supplies gases in a continuous manner.

3. Because these inventions are distinct for the reasons given above and have acquired a separate status in the art as shown by their different classification, restriction for examination purposes as indicated is proper.

4. During a telephone conversation with Joe Muncy on 10/25/2002 a provisional election was made with traverse to prosecute the invention of I, claims 1-21. Affirmation of this election must be made by applicant in replying to this Office action. Claims 22-25 are withdrawn from further consideration by the examiner, 37 CFR 1.142(b), as being drawn to a non-elected invention.

***Claim Rejections - 35 USC § 112***

5. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

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6. Claims 1-21 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Applicant recites the limitation of "predetermined purge times" in the last line of claim 1; "predetermined" is indefinite, likewise "predetermined" is indefinite for claims 2-21.

7. Claims 1-2 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. The language of claim 1 and 2 is unclear. Claim 1 recites "raw materials are supplied in one time each in the case when plural type of said crystal raw materials are alternately supplied in a pulsed manner with maintaining each of predetermined purge times." It is unclear whether raw materials are supplied together in one time or alternately, which contradicts the one time supply. "supplied in a pulsed manner with maintaining each of predetermined purge times, is unclear because maintaining each implies a steady flow of raw materials instead of a pulsed flow and "each" is unclear. Claim 2 has similar unclear language.

8. Claim 1-3 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Claim 1 recites "with maintaining each of predetermined purge times" it is unclear what is being maintained. It is unclear if the raw material is being maintained or purge times are being maintained, likewise for claims 2-3.

*Claim Objections*

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9. Claim 21 is objected to because of the following informalities. The abbreviations "TMGa", "(Cp)<sub>2</sub>Mg" and "TESi" should be preceded or replaced with the chemical name, for example Trimethyl gallium. Appropriate correction is required.

***Claim Rejections - 35 USC § 102***

10. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

11. Claims 1, 2, 3, 6, 7, 11, 12, 16 and 17 are rejected under 35 U.S.C. 102(b) as being anticipated by Nishizawa et al (US 5,693,139).

Nishizawa et al discloses a method of growing doped semiconductor monolayers, note entire reference, comprising raw material gases of Gallium (Ga) and Arsenic (As), where Ga is supplied for 0.5 to 10 seconds, the chamber is evacuated, this reads on applicant's purged for a predetermined time, and As is supplied for 2 to 200 seconds and the cycle is repeated (col 7, ln 1-67; col 8, ln 1-30 and Fig 7B and Fig 11). Nishizawa et al also discloses a p-type layer is formed by introducing an impurity gases and Ga simultaneously but alternately with an As source, where the impurity gas is a Mg, Zn or Cd containing gas or Silane. Nishizawa et al also discloses a n-type layer doped with Se or S and the impurity gas is introduced cyclically with the Ga gas and As gas or the impurity gas and Ga gas are introduced simultaneously but alternately with the As gas (col 8, ln 31-60). Nishizawa et al also discloses forming pnp bipolar transistors (col 8, ln 61-67). Nishizawa et al also discloses nozzles 44, 45 and 46 for introducing gaseous

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compounds used for impurity doping for introducing group II, IV and VI gases (col 10, ln 50-67). Nishizawa et al also discloses different modes of doping, where the dopant is added at the exhaustion of an As gas, the introduction of a Ga gas, the exhaustion of a Ga gas or at the introduction of As gas (col 11-13 and Fig 11). Nishizawa et al also discloses other III-V semiconductors are applicable to the invention (col 14, ln 5-55). Nishizawa et al also discloses introduction of a Ga source gas and a group II dopant simultaneously to form a p-type layer (col 8, ln 30-45) and the introduction of a group IV dopant after the introduction of a Ga source gas (col 15, ln 5-50). Nishizawa et al also discloses selection of the timing of doping with respect of the source gas introduction is based on the desired dopant type for the monolayer being grown (col 15, ln 45-55).

Referring to claim 1-2, Nishizawa et al discloses n-type and p-type impurities supplied in a pulsed manner at close timings at or after starting a supply of a raw materials which are alternately supplied in a pulsed manner with maintaining each of predetermined purge times for forming pnp junctions (Fig 11).

Referring to claim 3, Nishizawa et al discloses a first impurity and second impurity gas introduced at or after starting a first raw material gas and before starting a supply of a second raw material, where the first and second raw materials are supplied in one time when the raw material gases are supplied alternately with a second crystal material with maintaining a purge time. The first impurity gas for forming a p-type layer and the second impurity gas for forming a n-type layer in a pnp junction.

***Claim Rejections - 35 USC § 103***

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12. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

13. Claims 1-21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nishizawa et al (US 5,693,139) in view of Edmond et al (US 5,739,554).

Nishizawa et al discloses all of the limitations of claim 4 for forming n-type and p-type semiconductor layers, as discussed previously, except the second impurity raw material is started after finishing the supply of the first impurity raw material gas.

Edmond et al teaches a gallium nitride (GaN) layer codoped with both a Group II acceptor and Group IV donor (col 4, ln 50-67), where the group II acceptors include Zn or Mg and the Group IV donors include Si or Ge (col 6, ln 20-50). Edmond et al also discloses the GaN layer is formed by CVD, where Trimethylgallium (TMG), ammonia, silane and biscyclopentadienyl magnesium, (Cp)<sub>2</sub>Mg are used as reactant gases (col 7, ln 45-67 and col 8, ln 1-50). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Nishizawa et al with Edmond et al to form a co-doped GaN layer useful as an active layer (Abstract).

Referring to claim 4, the combination of Nishizawa et al and Edmond et al teaches forming a co-doped GaN layer using Mg and Si dopant, where the compound semiconductor layer is grown in monolayer by alternate introduction of source gases and the chamber being evacuated continuously throughout the whole method ('139 col 3, ln 35-45) and the Si is



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introduced after the Ga source gas to act as a donor and a Ga source and a Mg dopant are introduced simultaneously but alternately with a As source

Referring to claim 5, the combination of Nishizawa et al and Edmond et al teaches the introduction of a group IV dopant after the introduction of Ga and prior to the introduction of As and the introduction of group II dopant after the introduction of Ga and prior to the introduction of As (col 13, ln 10-35 and Fig 11).

Referring to claim 6-10, the combination of Nishizawa et al and Edmond et al teaches a Ga as first raw material gas and As or N as a second raw material gas.

Referring to claim 11-20, the combination of Nishizawa et al and Edmond et al teaches a co-doped layer with p-type and n-type impurities.

Referring to claim 21, the combination of Nishizawa et al and Edmond et al teaches using a silane dopant gas. The combination of Nishizawa et al and Edmond et al does not teach using a TESI dopant gas. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Nishizawa et al and Edmond et al by substituting TESI gas for silane because TESI is an equivalent Si source for doping and substituting equivalents for the same purpose is obvious (MPEP 2144.06).

14. Claim 21 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nishizawa et al (US 5,693,139) in view of Edmond et al (US 5,739,554) as applied to claims 1-20 above, and further in view of Manabe et al (US 6,472,690).

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The combination of Nishizawa et al and Edmond et al teaches all of the limitations of claim 21, as discussed previously, including using silane as a Si dopant. The combination of Nishizawa et al and Edmond et al does not teach supplying TESI

In a method of forming a gallium nitride compound semiconductor, note entire reference, Manabe et al teaches forming a n<sup>-</sup> type Gallium nitride layer, using silane or tetraethylsilane (TESi) (Example 4). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Nishizawa et al and Edmond et al with Manabe et al because substituting known equivalents for the same purpose is obvious (MPEP 2144.06).

### ***Conclusion***

15. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Sandhu et al (US 5,332,689) teaches pulsing reactant gases and dopant gases in alternating fashion (col 4).

Arimoto (US 5,082,798) teaches depositing Ga and a Si dopant together to form a n-type layer(col 2).

Ishida et al (US 6,198,112) teaches depositing GaAs/GaN superlattice by a monolayer growth process, note entire reference.

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16 Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew J Song whose telephone number is 703-305-4953. The examiner can normally be reached on M-F 9:00-5:00

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Benjamin L Utech can be reached on 703-308-3868. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9310 for regular communications and 703-872-9311 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.

Matthew J Song  
Examiner  
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MJS  
November 6, 2002

